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$$= \tfrac{1}{16}(\sqrt{30} + \sqrt{10} - \sqrt{6} - \sqrt{2}) + \tfrac{1}{16}\Big(\sqrt{10 + 4\sqrt{5}} + \sqrt{10 - 4\sqrt{5}}$$

$$- \sqrt{30 + 12\sqrt{5}} - \sqrt{30 - 12\sqrt{5}}\Big)$$

$$= \tfrac{1}{16}(\sqrt{30} + \sqrt{10} - \sqrt{6} - \sqrt{2}) + \tfrac{1}{16}(1 - \sqrt{3})\left(\sqrt{10 + 4\sqrt{5}} + \sqrt{10 - 4\sqrt{5}}\right).$$

By simplifying the expression in the last parenthesis and then collecting under the radical sign, we have, after a simple reduction,

$$\sin 3^\circ = \tfrac{1}{16}(\sqrt{30} + \sqrt{10} - \sqrt{6} - \sqrt{2}) + \tfrac{1}{8}\left(\sqrt{5 + \sqrt{5}} - \sqrt{15 + 3\sqrt{5}}\right).$$

Also solved by L. E. MENSENKAMP, J. L. RILEY, HORACE OLSON, H. S. UHLER, H. C. FEEMSTER, FLORENCE RAE, R. M. MATHEWS, H. L. AGARD, GILBERT A. AULT, FRANK IRWIN, C. E. GITHENS, A. M. HARDING, and the PROPOSER.

491 (Algebra). Proposed by J. W. LASLEY, University of North Carolina.

Solve the equations $xy = x^2 - y^2$ and $x^2 + y^2 = x^3 - y^3$ for x and y.

SOLUTION BY J. W. BALDWIN, Ann Arbor, Michigan.

Solving $xy = x^2 - y^2$ for x in terms of y we have $x = \frac{1}{2}(1 + \sqrt{5})y$ and $x = \frac{1}{2}(1 - \sqrt{5})y$. These values substituted in $x^2 + y^2 = x^3 - y^3$ give, after simplification, $y^2(y - \frac{1}{2}\sqrt{5}) = 0$ (1) and $y^2(y + \frac{1}{2}\sqrt{5}) = 0$ (2). From (1), $y = 0, 0, \frac{1}{2}\sqrt{5}$ and from (2) $y = 0, 0, -\frac{1}{2}\sqrt{5}$. Hence, the corresponding values of x are $0, 0, (5 + \sqrt{5})/4$ and $0, 0, (5 - \sqrt{5})/4$. From (1) or (2) it is seen that two branches of the curve represented by the second equation pass through the origin. It is readily determined that these branches are imaginary and, hence, the origin is a conjugate point.

Also solved by S. E. RASOR, F. H. HOLESTIN, ELGIN E. GROSECLOSE, H. N. CARLETON, A. M. HARDING, J. L. RILEY, POLYCARP HANSEN, E. B. ESCOTT, G. Y. SOSNOW, J. Q. MCNATT, O. S. ADAMS, HORACE OLSON, T. C. AMICK, L. E. LUNN, PAULINE SPERRY and the PROPOSER.

433 (Calculus). Proposed by LOUIS O'SHAUGHNESSY, University of Pennsylvania.

Solve the differential equation

$$\frac{d^{\frac{1}{2}}y}{dx^{\frac{1}{2}}} - \frac{y}{x} = 0.$$

I. SOLUTION BY EMIL L. POST, New York City.

We have

$$x\frac{d^{\frac{1}{2}}y}{dx^{\frac{1}{2}}} = y. \tag{1}$$

Operating on both sides by $d^{\frac{1}{2}}/dx^{\frac{1}{2}}$ (see next problem), we have

$$\frac{d^{\frac{1}{2}}}{dx^{\frac{1}{2}}}\left[x\frac{d^{\frac{1}{2}}y}{dx^{\frac{1}{2}}}\right] = \frac{d^{\frac{1}{2}}y}{dx^{\frac{1}{2}}}. \tag{2}$$

But for any operation $f(D)$

$$f(D)u\cdot v = uf(D)v + \frac{du}{dx}\frac{f'(D)v}{1!} + \frac{d^2u}{dx^2}\frac{f''(D)v}{2!} + \cdots.$$

Let

$$f(D) = D^{\frac{1}{2}} = \frac{d^{\frac{1}{2}}}{dx^{\frac{1}{2}}}; \qquad u = x; \qquad v = \frac{d^{\frac{1}{2}}y}{dx^{\frac{1}{2}}}.$$

Then

$$\frac{d^{\frac{1}{2}}}{dx^{\frac{1}{2}}}\left[x\frac{d^{\frac{1}{2}}y}{dx^{\frac{1}{2}}}\right] = x\frac{d^{\frac{1}{2}}}{dx^{\frac{1}{2}}}\frac{d^{\frac{1}{2}}y}{dx^{\frac{1}{2}}} + \frac{1}{2}\frac{d^{-\frac{1}{2}}}{dx^{-\frac{1}{2}}}\frac{d^{\frac{1}{2}}y}{dx^{\frac{1}{2}}} = x\frac{dy}{dx} + \tfrac{1}{2}y. \tag{3}$$